III. SURFACE WATER ASSESSMENT

A. SURFACE WATER MONITORING PROGRAMS

The Office of Water Resources' (OWR) surface water monitoring program is designed to gather state-wide baseline data in addition to targeted monitoring information. The data is used in establishing and reviewing the state's water quality standards, to measure progress toward achieving the state and federal water quality goals, and to supply information for use in development of permit limits for wastewater discharges and Total Maximum Daily Loads (TMDL's). Current surface water monitoring programs include activities conducted by the OWR staff as well as monitoring carried out by other agencies/organizations under contracts with OWR. The surface water monitoring program consists of targeted and probability based station sites, intensive surveys, special studies, and volunteer monitoring programs.

1. Beach Monitoring Program

In 2000 and 2001, there were 117 bathing water facilities licensed with the Rhode Island Department of Health (HEALTH). Of the 117 licensed facilities, 82 were tested for fecal coliform through HEALTH's Bathing Beaches Program. The remaining 35 bathing water facilities were exempt from testing requirements based upon the waterbodies' profile evaluations, past test results, and test results from DEM's Shellfish Growing Area Monitoring waters which are in close proximity to these bathing areas. Results were compared with the state's water quality standards for swimming, the fecal coliform standards for Class B and Class SB waters. Any beaches exceeding the criteria were resampled immediately. HEALTH has the jurisdiction to close any licensed bathing area when there is a violation of Rhode Island's water quality standards for swimming use.

Prior to the start of the 2001 bathing season, HEALTH created a new Bathing Beaches Website which included information concerning all licensed bathing facilities within the state. This website is a major milestone for the beaches program, given that there was no existing forum of publicly accessible information regarding beaches prior to this website.

2. Shellfish Growing Area Monitoring

The Shellfish Growing Area Monitoring Program is part of the State of Rhode Island's agreement with the USFDA's National Shellfish Sanitation Program (NSSP). The purpose of this program is to maintain national health standards by regulating the interstate shellfish industry. The NSSP is designed to oversee the shellfish producing states' management programs and to enforce and maintain an industry standard. As part of this agreement, the State of Rhode Island is required to conduct continuous bacteriological monitoring of the shellfish harboring waters of the State to maintain certification of these waters for shellfish harvesting for direct human consumption. Shoreline surveys are an additional requirement of the NSSP (see below). Rhode Island collects samples from 17 separate shellfish growing areas and analyzes for total and fecal coliform bacteria. These growing areas encompass all of Narragansett Bay and its shellfish harboring tributaries, all the south shore coastal salt ponds, Little Narragansett Bay, and Block Island. Each of the 17 growing areas incorporate anywhere from 9 to 39 fixed sampling stations.

Water samples are collected monthly at the 9 stations in the Upper Narragansett Bay, the 16 stations in the Warren and Barrington Rivers, the 19 stations in Greenwich Bay, the 10 stations in the Kickamuit River, and the 16 stations in Mt. Hope Bay, when those conditionally approved areas are open for shellfish harvesting. The results are used to manage those conditionally approved shellfish growing areas. The other shellfish growing areas in Rhode Island are not subject to the volume and number of sewage discharges that affect the Upper Narragansett Bay or the predictable nonpoint source impact that affects the Warren and Barrington Rivers, Greenwich Bay, the Kickamuit River and Mt. Hope Bay. Accordingly, these other shellfish growing areas are monitored less frequently. Prior to March 1981, there was no regular schedule for sampling these other areas. Sampling in a particular area was done as an intensive survey on an infrequent basis. In March 1981, the sampling program was expanded and has continued through present. The emphasis has shifted to a trend-oriented monitoring program. At present, those growing areas that are approved for shellfish harvesting are sampled a minimum of six times a year. An attempt is made to sample growing areas that are prohibited to shellfish harvesting a minimum of once a year.

Phytoplankton sampling has been added to the shellfish sections routine monitoring program. This process began in July 2000 and ran through October 2000, and will continue on an annual basis as part of the section routine sampling for the presence of fecal coliform. Protection of public health is the primary reason for this sampling. The introduction of this monitoring program will provide a basis for targeting where shellfish meats should be collected for bio assay which determines the need for the closure of shellfish grounds because of the presence of Paralytic Shellfish Poisoning (PSP) and Amnesic Shellfish Poisoning (ASP).

The role of the Office of Water Resources (OWR) is to collect two (2) phytoplankton samples during daily monitoring runs in Narragansett Bay. A memorandum of understanding between The Department of Health and the Department of Environmental Management states that the OWR shellfish section will collect an average of two (2) samples per week. The additional sampling will make up for the weeks when bay runs are unable to be completed due to foul weather or when mechanical problems arise with the monitoring boats. These samples will also serve in the creation of a Bio Toxin phytoplankton database.

Water Resources personnel collects and delivers the plankton samples to the Department of Health (DOH) Laboratory where they are analyzed and identified by food chemistry laboratory personnel. The identification is performed visually using a lab microscope, identification keys and photo's provided by The Food and Drug Administration (FDA). Three slides are prepared for each sample that is brought into the lab and the slides are examined for Alexandrium and Pseudonitzchia sp. at 100x and 250x. A sample Collection Form is filled out and a lab number is assigned to each sample submitted to the lab. The results of the identification are noted on the form and a copy is returned to the OWR and a copy is forwarded to the Office of Food Protection (DOH).

P. Christopher Ellis, PH.D, Supervisor Public Health Laboratories, identified phytoplankton samples for the 2000-sampling season. The identification was performed in the Food Chemistry Lab at the (DOH) Laboratory Building. Twenty-eight (28) samples were collected at eleven (11) different Growing Areas. Biotoxins were not present in any of the eighty-four (84) slides that have been analyzed.

The data collected will be stored in the computer and will be put into a report format displaying the date, growing area, tide, water temperature, wind direction, and lab result. The sampling schedule begins in early April and will continue through October. Samples are collected at random stations from every growing area in Narragansett Bay and also for the first

time in the coastal shore ponds.

3. Shoreline Surveys

Shoreline surveys are an additional requirement of the National Shellfish Sanitation Program (NSSP). These surveys are necessary to determine shellfish classification in a particular growing area and to locate all actual and potential bacterial sources. Such surveys involve an intense examination of the shoreline to identify all running pipes and tributaries for bacteriological quality as well as calculating flow rates, and then evaluating the impact upon specific growing areas. Inactive pipe sources and drainage ditches are also documented for future reference and evaluation. A shoreline survey must be performed every three years for each approved and conditionally approved growing area to meet NSSP criteria. Annual shoreline survey updates are also required each year for all approved and conditionally approved growing areas to ensure they are appropriately classified and to re-evaluate pollution sources previously identified. Water quality statistical analyses from routine sampling runs are required in conjunction with the status of any pollution sources identified during previous shoreline surveys. The Shoreline Survey Program is discussed in more detail in Chapter H – Public Health/Aquatic Life Concerns.

4. USGS Monitoring Fixed Stations

The Office of Water Resources has contracted with the U.S. Geological Survey (USGS) to conduct riverine monitoring in Rhode Island. Samples are collected at 7 stations described below.

Site	River	Location.
1	Blackstone	Blackstone R. at Millville, MA.
2	Branch	Branch R. at Forestdale, RI
3	Blackstone	Blackstone R. above Manville Dam
4	Pawtuxet	Pawtuxet R. at Cranston RI
5	Pawtuxet	Pawtuxet R. at Pawtuxet, RI
6	Pawcatuck	Pawcatuck R. at Westerly RI
7	Taunton	Taunton River at East Bridgewater, MA

All of the results are published in the U.S. Geological Survey publications, "Water Resources Data: Massachusetts and Rhode Island," on an annual basis. Table 3A-1 lists the analyses performed and the sampling frequencies

5. Chemical Baseline Monitoring

In 1991, to supplement the limited number of river stations monitored, RIDEM developed a cooperative agreement with URI's Civil and Environmental Engineering Department to conduct a study establishing a baseline monitoring program for the rivers of RI. During 1991, 1993, 1996, and 1998 through 2000 approximately twenty-five stations (Table 3A-2), selected from the forty-five Rapid Bioassessment Protocol (RBP) biological stations (see section III.A.7.c. below), have been monitored under this program. Water quality samples from these 25 locations are collected on a quarterly (seasonal) basis. The grab samples are analyzed for trace metals, nutrients, dissolved oxygen and other parameters (Table 3A-3). Funding problems prevented the development of a cooperative agreement with URI for this monitoring program in 1995 and 1997. Fortunately a long term agreement and funding are now in place for this project and consistent quarterly sampling of these 25 sites started in 1998.

The 25 stream stations monitored have afforded at least a limited baseline snapshot of water quality conditions where data was previously lacking. In addition, this program has allowed for a comparison of chemical water quality data with the biological assessment information from the RBP study, at these 25 sites.

Table 3A-1 Parameters measured at USGS Fixed Stations

MEASURED QUARTERLY
WATER COLUMN SAMPLING

Field determinations
- Streamflow
- Water temperature
- Specific Conductance
- pH
- Dissolved oxygen
- Alkalinity

Biological characteristics
- Fecal coliform bacteria
- E-Coli

Major nutrients

Nitrogen
- Dissolved nitrite
- Dissolved nitrate
- Dissolved $NO_2 + NO_3$
- Dissolved ammonia

Phosphorus
- Total Phosphorus
- Total orthophosphate

5 day biochemical oxygen demand (BOD)

Total Organic Carbon (TOC)

Suspended Sediments

Trace Elements

Total manganese	Total arsenic	Total iron	Total mercury
Dissolved selenium	Dissolved zinc	Total aluminum	Dissolved lead
Dissolved silver	Dissolved cadmium	Dissolved copper	Dissolved nickel
Dissolved chromium	Dissolved molybdenum		

MEASURED TWICE YEARLY
WATER COLUMN SAMPLING

Common constituents

Dissolved calcium	Dissolved chloride	Dissolved potassium	Dissolved sodium
Dissolved magnesium	Dissolved sulfate	Dissolved fluoride	

Other Constituents

Color COD Phenols, total Turbidity
ROE at 105 °C total and suspended

MEASURED ONCE YEARLY DURING PERIODS OF LOW STREAM FLOW
STREAM BOTTOM SEDIMENTS

Organic compounds

Total aldrin	Total dieldrin	Total DDD	Total DDE
Total DDT	Total endosulfan	Total endrin	Total PCB
Total PCN	Total lindane	Total heptachlor	Total mirex
Total methoxychlor	Total perthane	Total toxaphene	Total chlordane
Total heptachlorepoxide			

TABLE 3A-2 STREAM SAMPLING SITES FOR 1992 - 2000 RWU/URI

BIOLOGICAL AND CHEMICAL MONITORING

STREAM	TOWN	SAMPLING LOCATION	BIOLOGICAL MONITORING	CHEMICAL MONITORING
Abbot Run Brook (No)	Cumberland	Route 120	1992 - 2000	'91,'93,'96-'00
Abbot Run Brook (So)	No. Attleboro	Valley Rd.	1992 - 2000	'91,'93,'96-'00
Adamsville Brook	Adamsville	At USGS gage on Rt. 81 (Crandall Rd)	1992 - 2000	1991
Ashaway River	Hopkinton	At Rt. 216 below bridge	1992 - 2000	'91,'93,'96-'00
Bailey's Brook	Middletown	Kempenaar's Clambake (private rd)	1992 - 2000	'91,'93,'96-'00
Beaver River	Richmond	Shannock Hill Rd.	1992 - 2000	'91,'93,'96-'00
Big River	W. Greenwich	South side of Rt 3	1992 - 2000	'91,'93,'96-'00
Blackstone River	Lincoln	Below Manville Dam	1992 - 2000	-
Buckeye Brook	Warwick	Rt 117A at Lockwood Corner	1992 - 2000	-
Bucks Horn Brook	Coventry	At Lewis Farm Rd	1992 - 2000	'91,'93,'96-'00
Canonchet Brook	Hopkinton	Woodville\Alton Rd	1992 - 2000	'91,'93,'96-'00
Carr River	W. Greenwich	Burnt Saw Mill Rd	1992 - 2000	-
Chipuxet River	Exeter	Wolf Rocks Rd	1992 - 2000	'91,'93,'96-'00
Clear River	Burrillville	Victory Highway	1992 - 2000	'91,'93,'96-'00
Cold Brook	Little Compton	Pottersville Road	1992 - 2000	-
Congdon Brook	W. Greenwich	At south side of bridge near old foundation	1992 - 2000	-
Dolly Cole Brook	Foster	Old Danielson Pike	1992 - 2000	-
Dundery Brook	Little Compton	Swamp Road	1992 - 2000	'91,'93,'96-'00
Fall River	Exeter	North of Route 165	1992 - 2000	'91,'93,'96-'00
Hardig Brook	Warwick	Toll Gate Rd near Little Gorton Pd	1992 - 2000	'93,'96-'00
Hemlock Brook	Foster	150 m W of Hemlock Rd bridge	1992 - 1995	-
Hunt River	E. Greenwich	Route 1	1992 - 2000	'91,'93,'96-'00
Jamestown Brook	Jamestown	Watson Farm Road	1992 - 1998, 2000	'91,'93,'96-'00
Keech Brook	Burrillville	At covered bridge in Geo. Washington Mgmt. Area	1992 - 2000	'91,'93,'96-'00
Kickamuit River	Swansea,MA	At Poverty Corner Road	1993 - 2000	-
Lawton Valley Brook	Portsmouth	Below Newport Res. Off Rt 114	1993 - 2000	-
Maidford River	Middletown	Prospect Avenue	1992 - 2000	'91,'93,'96-'00
Maskerchugg River	E. Greenwich	Route 1 before Goddard Park	-	'91,'93,'96-'00
Meadow Brook	Richmond	Pine Hill Rd (Carolina Management Area)	1992 - 2000	'91,'93,'96-'00
Moosup River	Coventry	At Rt 14 Bridge	1995 - 2000	-
Moswansicut Brook	Scituate	Near Rt. 116, west 80 m - below old stone bridge	1992 - 1995	-
Nipmuc River	Burrillville	South of Brook Road - Top Brk. Below pool	1992 - 2000	-
Nooseneck River	W. Greenwich	West side of Rt 3	1992 - 2000	-
Palmer River	Rehoboth,MA	At County Street	1995 - 1998	-
Parris Brook	Exeter	Blitzkreig Trail	1992 - 2000	'91,'93,'96-'00
Pascoag River	Burrillville	Grove St. bridge	1992 - 2000	'91,'93,'96-'00
Pawcatuck River	Westerly	Below White Rock Bridge	1993 - 2000	-
Pawtuxet River	Cranston	At USGS gage in Cranston	1992 - 2000	-
Queens River	Exeter	Liberty Road	1992 - 2000	'91,'93,'96-'00
Round Top Brook	Burrillville	Brook Road	1992 - 1993	'91,'93,'96-'00
Runnins River	Seekonk	At Rt 44 bridge	1993, 1995 - 2000	-
Rush Brook	Scituate	100 m W of Elmdale Bk	1992 - 1995	-
Saugatucket River	Wakefield	Rt 1A bridge	1992 - 2000	-
Silver Creek	Bristol	At Chestnut Street	1993 - 2000	-
Swamp Brook	Scituate	15 m NW of inflow pt. of Ponaganset Rv. into Scituate Res.	1992 - 1995	-
Ten Mile River	E. Providence	Broadway Bridge	1992 - 1998, 2000	-
Tomaquag Brook	Hopkinton	Chase Hill Rd	1992 - 2000	'91,'93,'96-'00
Wilbur Hollow Brook	Scituate	3 m N of culvert crossing on Old Plainfield Pike	1992 - 1995	-
Wood River	Richmond	North of Skunk Hill Rd off Old Nooseneck Road	1992 - 2000	'91,'93,'96-'00
Woonasquatucket River	Providence	Eagle Street Bridge	1992 - 2000	-

TABLE 3A-3

PARAMETERS MEASURED QUARTERLY BY URI AT BASELINE MONITORING SITES

Ammonia as N (NH_3)
Chloride
Conductivity
Dissolved Cadmium
Dissolved Copper
Dissolved Lead
Dissolved Oxygen
Fecal Coliform
Hardness
Instantaneous Flow
Nitrates as N (NO_3)
Orthophosphate as P
pH
Sodium
Temperature
Total Iron
Total Phosphorus
Total Suspended Solids
Turbidity
Unfiltered BOD_5
Volatile Suspended Solids

6. Biological Monitoring

a. General

The importance of biological assessments in the evaluation of water quality has long been recognized in Rhode Island. Biological assessments are evaluations of the biological condition of waterbodies using biological surveys and other direct measurements of resident biota in surface waters. Biological assessments are used to supplement physical and chemical water quality monitoring data. More specifically, the biological data can be used to identify long-term trends in water quality which reflect water pollution abatement efforts and/or needs. The survival of a species or aquatic community is dependent upon favorable instream environmental conditions. The effects of pollutants are evidenced in the population of organisms, species composition and diversity, and the physiological condition of natural aquatic communities.

The RIDEM, OWR uses two types of biological monitoring programs. Multiple plate artificial substrates have been used to evaluate the biological community in deep rivers since 1974. In addition, EPA's Rapid Bioassessment Protocol (RBP) has been used since 1991 for the assessment of the biological integrity of various shallow river sites in the state.

b. Artificial Substrate Monitoring

The Fullner multiple-plate artificial substrate with 14 plates has been used by DWR for over 27 years to assess instream biological communities. Stations selected for this biological monitoring include those used for USGS trend chemical sampling (Table 3A-4). The purpose of this was to more closely relate chemical and biological data. This method has the advantage of providing a uniform sampling habitat for each station, thus reducing the problem caused by varying types of river bottom and depth.

Macroinvertebrates (mostly aquatic insect larvae) collected on the artificial substrates are classified according to their tolerance of pollutants. For the Division's biological analyses, organisms were counted and placed in one of the three categories described below:

1. Tolerant - Organisms frequently associated with gross organic contamination and generally capable of thriving under periods of anaerobic conditions, some even in the presence of toxic wastes.

2. Facultative or Intermediate - Organisms having a wide range of tolerance and frequently associated with moderate levels of organic contamination.

3. Intolerant or Sensitive - Organisms that are not found associated with even moderate levels of organic contaminants and generally intolerant of even moderate reductions in dissolved oxygen.

Table 3.A-4 Biological River Stations (1999-2000)

BRANCH RIVER

Forestdale, Rt. 146A

BLACKSTONE RIVER

Rt. 122, Millville, MA

Manville Dam

PAWTUXET RIVER

Cranston Gage

Pawtuxet Village, Rt. 1A

PAWCATUCK RIVER

Westerly Gage

CONTROL

Wood River, Skunk Hill Rd.

c. Rapid Bioassessment Protocol Monitoring

The Rapid Bioassessment Protocol (RBP) involves an integrated assessment, comparing habitat (physical structure, flow regime) and biological measures with defined reference site conditions. EPA originally designed these protocols as inexpensive screening tools to determine if a stream is supporting or not supporting a designated aquatic life use. However, the protocol are now considered applicable to a wider range of planning and management purposes. They may be appropriate for priority setting, point and nonpoint source evaluations, use attainability analyses, and trend monitoring.

Since 1992, a network of 45 stream riffle-area sites (Table 3A-2) have been surveyed by Roger Williams University in cooperation with and contracted by RIDEM. Each site is visited during the spring-summer season and macroinvertebrates are sampled (minimum 100 organisms per site visit where feasible). Data are analyzed using RBP I and II protocol which include varying degrees of field and laboratory organism identification.

The streams sampled within the state range in stream order from first order to fifth order. Eight of the streams are considered to be first order, eighteen second order, 12 third order, four fourth order and three are of the fifth order. Lower order streams are quite dependent upon the immediate characteristics of the watershed. In other words, runoff is a direct-affect component versus one of many components within a higher order stream. It is important to note that the 1993, 1995 and 1997 sampling events were during drought conditions which may have resulted in fewer riffles, lower dilution and lack of runoff. This probably affected the types of organisms collected and resulted in an altered picture of the stations based on the metrics, from that seen in other

years. This information was taken into account during the evaluation of the biological assessments.

Initial bioassessment work involved establishing and field testing the Rapid Bioassessment Protocols in Rhode Island streams and rivers. Fall River was selected as the reference station in 1992, however, further evaluation has resulted in using the Wood River station as the reference site since 1993. In addition, refinement of the protocol over the past 6 years has established the presence of two sub-ecoregions within the state: coastal areas and inland areas. Incorporation of the presence of these two sub-ecoregions into selection of reference sites and application of the protocols will continue.

The habitat and physical parameters and biological metrics of each station were compared to those of the selected reference station and given an overall bioassessment score. The bioassessment categories include:

(1) nonimpaired - Comparable to the best situation to be expected within an ecoregion. Balanced trophic structure and optimum community structure for the stream size and habitat quality.

(2) slightly impaired - Community structure less than expected. Species composition is lower due to the loss of some intolerant forms. Percent contribution of tolerant forms increases.

(3) moderately impaired - Consists of fewer species due to loss of most intolerant forms.

(4) severely impaired - Few species present and often dominated by one or two species.

7. Long-term Monitoring of Narragansett Bay Watershed

The Narragansett Bay Estuary Program (NBNEP) has the duty and responsibility within RIDEM to coordinate implementation of the Narragansett Bay Comprehensive Conservation and Management Plan (CCMP). The Management Plan emphasizes the importance of development of a long term monitoring program on the Bay, and includes in its objectives the pursuit of monitoring which addresses the following issues:

- Detecting long-term changes in the functioning of the Bay ecosystem.
- Assessing the influence of changing anthropogenic pollutant loadings and the success of management actions.
- Establishing baseline data to detect events such as fisheries collapse and algal blooms and their interactions with ecological disturbances.
- Provide a framework to support on-going Bay Research

In recent years, monitoring efforts beyond the shellfish bacterial monitoring in the Bay have been limited to select subareas of Narragansett Bay based on limited, area-specific grant funding. Examples include the EPA funded Providence-Seekonk River TMDL Total Maximum Daily Loadings study and the National Oceanic and Atmospheric Administration (NOAA) - URI Sea Grant Greenwich Bay Initiative. However, thanks to seed money provided to RIDEM and URI by Sen. John Chafee of the R.I. Congressional delegation, a multi-partner Bay-wide monitoring system has been underway since 1998 through federal NOAA funding to a collaborative monitoring effort including URI, EPA, NOAA National Marine Fisheries Service

(NMFS), and RIDEM. A grant totaling $1.5 million for monitoring work on Narragansett Bay and other R.I. marine waters provided the first steps towards a comprehensive continuous monitoring system, and a second federal grant allowed expansion of the dissolved oxygen work as well as continued commitment to the Bay monitoring discussed below. In addition, USEPA EMPACT grant funds have also been leveraged to expand this system into the Providence /Seekonk River and Mount Hope Bay through a successful URI-Narragansett Bay Commission EPA rant proposal. Although there is extended commitment from NBC to maintain part of the Providence/Seekonk Rivers EMPACT program, there are no state funds available for continuation of the monitoring for the rest of the Bay, and it is unclear how long the state can sustain this work without further federal help. Therefore , the long-term prognosis for this invaluable collaborative monitoring program is uncertain.

The Narragansett Bay Estuary Program has aided in the technical planning and design of this state-of-the-art continuous monitoring system for all of Narragansett Bay. A technical steering committee oversees the project development, and includes scientists from NOAA/NMFS Narragansett & Woods Hole, URI Graduate School of Oceanography (GSO), and RIDEM. Portions of this bay-wide water quality monitoring system are based on the NBEP's Comprehensive Long-Term Monitoring Plan (Narragansett Bay Monitoring Plan Final Report to the NBP, June, 1992).

The in-Bay components of the monitoring system include at least 3 major efforts:

1. A monthly survey of the zooplankton (tiny floating animals critical to the food chain) in the Bay using an advanced computer-controlled shuttle towed behind a boat. The device can move up and down the water column, sampling zooplankton while simultaneously measuring depth, salinity, temperature, dissolved oxygen (D.O.), pH, and chlorophyll *a* as a tow boat covers set transects of the Bay. The present transect layout covers the Providence River, Upper Bay, Mount Hope Bay, and the East and West Passages.
2. Continuous water quality monitoring stations at 7 sites strategically selected around the Bay to provide a good picture of the overall health of the Bay. These stations will have continuous monitoring probes set at several depths measuring salinity, temperature, D.O., pH, tide height, and, for selected stations, turbidity and chlorophyll *a* .
3. Surface sediment samples and analyses for heavy metals and organics at 43 stations scattered around the Bay.

In addition to this water column monitoring effort, significant advances have been made through a collaborative program between NOAA NMFS Woods Hole and the RIDEM Fish & Wildlife to develop a standardized template to analyze fisheries management data in a manner that allows sharing of data between the State of R.I. and the NMFS New England fisheries management efforts. In addition, funds have been provided to the RIDEM Division of Fish & Wildlife to replace the ailing trawler now used for fisheries population data generation.

Much of the water column monitoring for this comprehensive effort is concentrated on issues related to excess nutrients and their impacts, including low dissolved oxygen. Sediment samples for toxics were taken in 1997 and 1998, with chemical analyses completed in late 1998, and all seven of the water column continuous monitoring probe stations are now operational, with an eighth station on the Seekonk (tidal) River scheduled to come on-line by 2002. Monthly transect sampling cruises of the zooplankton in the Bay have been ongoing since February 1998.

These stations include a RIDEM shore-based site at the Pomham Rocks area in the

Providence River. In addition, a U.S. EPA EMPACT grant to the Narragansett Bay Commission has funded the installation of three sampling stations placed in the Lower Providence River (Bullock Reach area), the Seekonk River, and Mount Hope Bay. The data for this monitoring system will eventually be posted and available to the public on the World Wide Web through the data center at the URI Graduate School of Oceanography/Coastal Institute at http://www.narrbay.org.

This collaborative effort should provide an excellent comprehensive picture of the present conditions of various aspects of the Narragansett Bay ecosystem. Unfortunately, the federal money which funded this work is running out (funds available to sustain work until ~ Jan 2002). Multi-year data at the level of decades is essential to discern actual trends from normally variable measurements (e.g., dry vs. wet years often change salinity and oxygen levels but may not constitute an actual permanent shift in the Bay). It is hoped that federal and other sources will recognize the critical value of this system in capturing changes in the bay ecosystem, providing a national example of a multi-agency/institution collaborative state-of-the-art monitoring effort that pools the significant marine expertise concentrated in the Ocean State in a highly cost-effective manner.

Early Results of the Bay Monitoring Program

Under the collaborative monitoring program, recent sediment data (1997-98) was acquired for 43 stations in the Bay, providing an integrated picture of recently deposited sediment pollutant loads. In addition, comparison of data from 20 of these stations with data from sediment samples taken for the original Narragansett Bay characterization study (1988-89) (and performed by the same researchers; Drs. King and Quinn, URI/GSO) provide an indication of pollutant loading trends over the last 10 years.

Results from King *et al.* (1998) show major decreases since the 1988-89 samples for trace metal concentrations in all metals analyzed in surface sediment samples taken from the most industrially-impacted areas of the Bay, the Providence / Seekonk tidal Rivers and the Taunton River (Mount Hope Bay). Stations from mid Bay areas showed little change or small increases in metals for the recent sampling, and followed the overall pollution gradient noted in the original Bay characterization study: greatest sediment pollution concentrations are always in the most industrialized/urbanized areas (e.g., Providence/ Seekonk Rivers) of the upper Bay, and decrease rapidly as one moves down bay. Measurements of Simultaneously Extracted Metal (SEM) concentrations and Acid Volatile Sulfides (AVS) indicate that the trace metals are not likely to be bioavailable at the stations with highest metal concentrations unless they become oxidized by human activities such as dredging.

The decrease in concentrations of metals in the most polluted stations from the recent (1997-8) sediment data has lowered the upper range seen in surface sediment concentrations for these metals, although highest levels are still nearest the major loading sources (major wastewater treatment facilities (WWTFs) and industrialized river mouths). This trend of decreasing metal concentrations likely reflects both the success of WWTF pretreatment programs and the decrease in the number of metal discharges from industries such as jewelry and electroplating due to the shift in the global manufacturing economy over the last 20 years. The small increases in metals in the sediments of the mid Bay areas may reflect atmospheric loadings of metals to the Bay.

For all organics analyzed (PAHs, PCBs, OCPs, TPH), concentrations in the surface sediments followed the same gradient as described above, with greatest levels found associated with urban sources and industrialized river mouths in the upper reaches of Narragansett Bay. These organic pollutants also showed a decrease in surface sediment concentrations at many

upper Bay stations since 1988-89, and significant decreases at stations closest to WWTF discharges. These results likely reflect the improvement in secondary treatment achieved over the last decade at the major WWTFs, another success story for the federal Clean Water Act, and a strong positive step towards recuperation of these areas as projected by the CCMP if treatment levels were improved at the WWTFs.

In contrast to these results, sediment nitrogen and carbon loads appear to have increased according to King *et al*. (1998), indicating that the Bay is experiencing a continued increase in nutrients and biological productivity response to those nutrients, again emphasizing the concerns over excess nutrient impacts.

Special Monitoring for Hypoxia

In addition to the above monitoring plans, The NBEP & NBNERR organized a voluntary effort during the summers of 1999, 2000, & 2001 to measure overnight decreases in dissolved oxygen across the entire upper half of Narragansett Bay using multi-agency boat teams to cover large areas of the Bay simultaneously. This multi-state/multi-institution dissolved oxygen survey included volunteers from the USEPA Boston, the EPA Atlantic Ecology Division Lab, EPA Lexington Lab, the Narragansett Bay Commission, RIDEM Narragansett Bay Estuary Program & NBNERR, Roger Williams University, Brown University, U.S. Fish & Wildlife, URI, Save The Bay, YSI, Inc., MACZM and others. The continued implementation of this effort is dependent on the availability of agency boat availability, needed funding and staff resources.

The goal of the NBEP surveys is to begin first steps towards mapping a sporadic hypoxic zone that is thought to be developing at least once every two years in the upper Bay under specific meteorological conditions. The final goal is to provide data useful to the State in the preliminary ongoing TMDL for excess nutrients, especially nitrogen, to the Providence /Seekonk Rivers.

Trends in Oxygen

In January 2000, the Rhode Island Sea Grant sponsored a symposium on recent research in Narragansett Bay. At that symposium, Dr. Deacutis of the NBEP presented preliminary results on the two dissolved oxygen surveys completed in summer 1999. Results indicated that several open areas of the upper Narragansett Bay and upper West Passage, Mount Hope Bay, and the western side of Greenwich bay show evidence of low oxygen condition (<4.0 ppm) during weak (neap) tides. There appears to be a risk that oxygen levels may go even lower in some of these areas, reaching hypoxic levels (< 2.0 ppm) on a sporadic basis in mid or late summer over parts of the upper half of the Bay.

Based on the evening DO surveys discussed above, this risk has now been clearly confirmed, especially in July 2001, with hypoxia found in much of Greenwich Bay and a significant part of the upper West Passage and Upper Bay as well as all of the Providence River and part of the upper East Passage.

Such events may be brief (on the order of days), but can have a significant and lethal effect on sensitive bottom species in the Bay. Such events may be contributing to the quantified shift from dominant benthic fish species to a pelagic fish community in Narragansett Bay over the last decade (RIDEM Fish & Wildlife). In addition, work initiated by the NBEP has shown that eelgrass, a critical nursery habitat for young fish and crabs, was at significantly higher abundance historically, but has now been eliminated from most of the upper half of the Bay due to poor

water clarity. Scientists agree that the bottom-line driving parameter for both these issues (low oxygen and poor water clarity) is the rapid growth of phytoplankton biomass in the Bay in areas receiving high loadings of nitrogen, both as ammonium and as nitrate. When these plants die, bacterial decomposition uses up much of the available oxygen in the bottom waters on very calm, hot nights in late summer, especially under conditions with even slight density stratification.

This issue is linked to the nutrient control workshop, *Nutrients and Narragansett Bay*, funded and coordinated by the NBEP in September 1998. This workshop brought together technical staff, scientists and policy-makers to discuss nutrient impacts on the Bay and ways that the problem can be addressed. It also provided general technical information on operational procedural changes at major WWTFs which can potentially significantly increase denitrification of the effluent (as presently being done at many Connecticut WWTFs).

The RIDEM WWTF operator's training program and the New England Interstate Water Pollution Control Commission (NEIWPCC) developed a follow-up workshop on June 9, 1999 in Providence titled the *Ocean State Nitrogen Optimization Program for Wastewater Treatment Facilities*. This program provided more specific engineering/operations information on the potential opportunities available to WWTFs to decrease nitrogen loads from their facilities through voluntary alterations in treatment operational procedures.

Proactive efforts in this area have a high likelihood of providing visible improvements in the Bay (e.g., through increased clarity of the water in the upper Bay and possibly decreases in incidence of hypoxia).

This effort to educate WWTF operators has been continued by the RIDEM WWTF operator training program. This program has worked with the New England Interstate Water Pollution Control Commission on an EPA-funded project to examine specific R.I. WWTFs and have experts from other states provide technical advice and insight to the operators of these plants on how feasible such denitrification enhancement treatments are likely to be at their specific plants under present configuration and tank capacities. The potential nitrogen loading decreases projected for some of the plants may exceed 50%.

8. Watershed Projects

Over the past few years the Department has initiated several intensive monitoring projects that are working towards the watershed approach and total maximum daily load (TMDL) development. Below is a synopsis of the intensive water quality monitoring projects presently being conducted or overseen by the Department.

a. <u>Providence-Seekonk Rivers</u>

The influence of nutrient loadings on eutrophication in the Providence and Seekonk Rivers is being addressed through a RIDEM nitrogen TMDL. Information to date indicates that the principal nutrient sources discharging to the Providence River are the Blackstone River, The Narragansett Bay Commission facilities at Fields and Bucklin Points, and the Pawtuxet River. These loadings cause high phytoplankton levels and large daily oscillations in dissolved oxygen, and the depletion of dissolved oxygen in the bottom waters of the rivers during the summer months. A study characterizing source loadings and the present condition of the system was performed by RIDEM during 1995 and 1996. RIDEM has collaborated with the Narragansett Bay Commission to obtain continuous measurements of water properties in the Providence River by

providing monitoring equipment and developing a monitoring station at Pomham Rocks in East Providence. The site provided data during 2000 and 2001 that shows for the first time how water properties, particularly dissolved oxygen and chlorophyll-a, vary over time in the upper Providence River.

DEM has contracted for the development of a water quality model of the rivers. The contractor presented results of testing the hydrodynamics component of the model to a technical advisory committee in the summer and fall of 2001. Comparisons between the water quality and 1995 field data are being conducted during the winter – spring of 2002. Testing of the water quality model has been in progress through the winter of 2002. It is expected that alternative reduction scenarios will be simulated during the spring and summer of 2002. It is expected that the draft TMDL document will be issued for public comment during the fall of 2002.

b. Barrington/Palmer/Warren River Estuary System

The Barrington and Palmer Rivers are impacted by fecal coliform loadings from their principal tributaries during dry and wet weather. The Palmer River estuary is also listed as impaired for nutrients. RIDEM studies characterized causes and impairments through wet and dry weather studies of the area during 1995-1998. The draft fecal coliform TMDL for the Barrington River, along with the Runnins River TMDL, was completed in May 2000 and presented for public comment in June 2000. The TMDL identifies the Runnins River as controlling bacteria elevations in the Barrington River, particularly during wet weather. Comments received from EPA led to continued modifications to both TMDL documents during 2000 – 2001. It is expected that the revised TMDLs will again be submitted for public comment in March 2002 and receive final approval by July 2002.

The Palmer River fecal coliform TMDL was submitted for public comment in January 2002. The TMDL identifies sources in the headwaters of the Palmer River, Rocky Run, and two streams at the head of Belcher Cove as controlling elevations in the river, particularly during wet weather. RIDEM has been working with Massachusetts agencies and the RI Division of Agriculture to reduce the pollution contamination potential from agricultural sites in the Belcher Cove area and in Massachusetts.

The Palmer River is also affected by excessive nutrient loadings. These loadings produce high seaweed accumulations that cover the bottom of the lower River, which in turn cause large fluctuations in dissolved oxygen in the River, with supersaturated daytime levels and low night-time levels. The condition results from nutrient loadings released by permitted discharges in downstream reaches of the Warren River and upstream loadings in the watershed. The shallow water depths of the lower Palmer River exacerbate the condition. RIDEM is scheduled to complete a nutrient reduction TMDL for the Palmer River in mid-2002.

c. Woonasquatucket River

As part of the "Special Place" Initiative Program, RIDEM is pursuing the location and investigation and elimination of dry weather discharges. RIDEM is also developing a strategy to address non-CSO wet weather discharges to the river. RIDEM has followed up on an earlier EPA survey that identified 317 outlet pipes to the river. RIDEM also checked storm drain plans for RIDOT and the cities and towns

along the river, adding 95 additional pipes and channelized entry points. Drain pipes identified as probable pollutant sources during initial surveys were re-surveyed during 2000 and 2001. RIDEM initiated more than a dozen complaints with the Office of Compliance and Inspection as a result of the pipe surveys.

RIDEM has planned further studies of the river to characterize wet weather impairments and causes. RIDEM and its contractor, The Louis Berger Group, have teamed with the Narragansett Bay Commission to conduct wet weather monitoring studies to bracket wet weather sources of metals and bacteria and instream concentrations during the spring and summer of 2002.

d. Narrow River

RIDEM submitted a fecal coliform TMDL for final EPA approval in December 2001 to address violations of water quality standards for fecal coliforms during dry and wet weather. The TMDL addresses three areas of concern along the river during dry weather. The causes include failed ISDS's, an outhouse, and wildlife and pet loadings. Removal of an outhouse resulted in a water quality improvement at one site. The Office of Compliance and Inspection is pursuing a potential failed septic system at a second site. RIDEM is working with a local watershed group on a public involvement and education program to address pet and waterfowl waste in a third area. TMDL also documented fecal coliform loadings in runoff from the heavily developed neighborhoods that impact the river in wet weather. The TMDL and previous studies have prompted the development of BMP designs at two locations along the river.

e. Crooked Brook

Crooked Brook was identified as impaired during the 1999 Narrow River TMDL. RIDEM completed its assessment of the brook during 2001 and submitted a draft TMDL for EPA review in December 2001. The TMDL identified natural sources (wildlife and waterfowl) as significant dry and wet weather sources. The TMDL specifies that mitigative actions be taken for controllable sources in the watershed that include storm drains in Narragansett and a hobby farm.

f. Hunt River

In 1996 and 1997, URI conducted an extensive water quality monitoring project for the Hunt watershed. URI collected water quality data from 22 sites within the watershed . The URI study was divided into two phases: a preliminary site assessment (dry weather water quality monitoring program) and a wet weather characterization. Violations of the fecal coliform bacteria standard were documented, under both dry and wet weather conditions, at several locations along the Hunt River mainstream and its tributaries. Dry weather dissolved oxygen concentrations met the standard of 5.0 mg/L at all stations, with the exception of violations at the most upstream stations in Sandhill and Frenchtown Brooks.

In 1999, RIDEM staff conducted supplemental monitoring in the Hunt River watershed to support the development of fecal coliform TMDLs for the Hunt River and Fry and Scrabbletown Brooks. This effort included ambient monitoring for fecal coliform at 34 sampling stations located along the mainstem of the Hunt River and many of its tributaries. Dry weather samples were collected from three to eight times at each station during the spring, summer, and fall of 1999. Wet weather samples were collected during two storm events.

RIDEM's water quality assessment found that most of the Hunt River and its tributaries do not fully support the designated uses for either Class A or Class B waterbodies during either dry or wet weather conditions. However, wet weather impacts were found to be very important. RIDEM identified 4 major wet weather sources of fecal coliform in the Hunt River watershed: stormwater runoff, resident waterfowl, a dairy farm, and roosting pigeons at a highway overpass. TMDLs for the three waterbodies were completed in the fall of 2000 and approved by EPA in early 2001. RIDEM has worked with the Towns and RIDOT to support implementation of the BMPs recommended by the TMDLs.

g. Portsmouth/Island Park

The Island Park and Portsmouth Park areas have chronic sewage contamination problems. Shellfishing is banned from adjacent waters due to the presence of high concentrations of fecal coliform bacteria in both dry and wet weather storm drain flows in the Portsmouth Park area. In the Island Park area suspected plumes of poorly treated sewage discharges to The Cove through rapid soils.

A draft total maximum daily load (TMDL) has been written and EPA has conducted a preliminary review. RIDEM has coordinated with the Town of Portsmouth to ensure that the findings of the TMDL are addressed in the Town's Wastewater Facilities Plan which is in the process of being revised. RIDEM anticipates that the TMDLs for the two waterbodies will be finalized in 2002.

h. Saugatucket River

In 1995, RIDEM contracted with URI's Civil and Environmental Engineering Department to conduct a water quality assessment of the Saugatucket River watershed. The project was conducted over a two-year period from 1996 to 1997. The intent of the project was to assess point and nonpoint sources of pollution to the river, with the results of the assessment being used to calibrate and validate a water quality model. Violations of the fecal coliform bacteria standard were documented under both dry and wet weather conditions. These violations occurred at several locations along the Saugatucket River mainstem and its tributaries Rocky Brook, Indian Run Brook, and Mitchell Brook. Furthermore, violations of the trace metal criteria were documented near the mouth of Indian Run Brook. RIDEM received a draft final report from URI in February 1999.

In 2000 and 2001, RIDEM staff conducted supplemental monitoring in the Saugatucket River watershed to support the development of TMDLs. This effort included monitoring for pathogens in the Saugatucket River and its major tributaries and copper, lead, and zinc in the Indian Run Brook watershed.

RIDEM's water quality assessment found that portions of the Saugatucket River and its tributaries do not meet the water quality standards for pathogens. Wet weather impacts were found to be critical. In addition to stormwater runoff, RIDEM also identified three other major sources of pathogens in the Saugatucket River watershed: a cow farm, and roosting pigeons under the Main Street bridge and at the Palisades Industrial Complex.

The water quality assessment for Indian Run Brook found that the lower portion of the Brook and one of its tributaries do not meet Class B water quality standards for dissolved copper, lead, and zinc. Wet weather impacts were found to be critical to trace metal loadings. RIDEM identified one major source of tract metal loads in Indian Run Brook: stormwater runoff from a seven-foot by 3-foot box culvert located at the intersection of Route 108, School Street, and Indian Run Road. TMDLs are currently being developed to address pathogen and trace metal water quality impairments and are expected to be completed in 2002.

Saugatucket Pond was listed as impaired for phosphorus and noxious aquatic plants on the 2000 303(d) list of impaired waters. RIDEM conducted water quality monitoring on Saugatucket Pond for total phosphorus during the summer of 2000. RIDEM's water quality assessment found that phosphorus levels did not violate the water quality standard, and that noxious aquatic plants present in the pond were the result of shallow depths and enriched sediments that allow aquatic plants to thrive. Since the noxious aquatic plants impairment is not due to a "pollutant," an aquatic plant management plan is being prepared in lieu of a TMDL. The aquatic plant management plan is expected to be complete in 2002.

i. Blackstone River

In 2001, RIDEM contracted with The Louis Berger Group, Inc. to complete a study to characterize water quality and identify data gaps in Valley Falls Pond and the Blackstone, Mill and Peters River watersheds. Impairments to be addressed include pathogens, nutrients and metals. The project will also include preparation and implementation of a monitoring plan, including the necessary QAPP documentation. The primary objective of this project is to provide the information needed to develop TMDLs for these targeted waterbodies. Water quality monitoring is scheduled to begin the fall of 2002 and go through the fall of 2003.

In January 2002, key stakeholders in the watershed were brought together to form a Technical Advisory Committee (TAC) to provide additional review of key project deliverables as they are completed by the contractor and submitted to RIDEM. It is anticipated that the final report characterizing water quality in the targeted waterbodies will be completed and submitted to RIDEM in 2004. This report will then support the development of the resulting TMDLs by RIDEM staff.

j. Sands Pond

Sands Pond serves as a back-up water supply for the Town of New Shoreham. It has been identified as impaired for excess algal growth, taste and odor, and turbidity. RIDEM conducted water quality monitoring and landuse assessment during the summer of 2001. Even though elevated levels of phosphorus were found in the pond, no readily apparent pollution sources were identified in the watershed. Past management practices and recycling of nutrients in the pond were thought to be the primary reasons for the impairment. In early 2002, RIDEM contracted with a consultant to sample pond sediments, develop a bathymetric map, and estimate sediment volume in the pond. This new information will assist the department in developing implementation measures to address the oversupply of nutrients in the pond.

k. Mashapaug Pond

Mashapaug Pond is a 77-acre pond located in the southwest corner of the City of Providence, an area with mix of older industrial and residential development. The pond was identified on the state's 2000 303(d) List of Impaired Waterbodies as impaired by nutrients and hypoxia.

Starting in 1999, URI Cooperative Extension's Watershed Watch program has had two volunteer monitors on the pond. The first summer's data showed water clarity of less than 1 m (out of a total depth of 5 m) and chlorophyll a levels that are considered to be highly eutrophic. Stratification occurred, starting in mid-June, and dissolved

oxygen levels fell to less than 2 mg/l near the bottom. Total phosphorus concentrations were also found to be quite elevated.

In 2001, RIDEM partnered with EPA to bring on a consultant to develop a TMDL for the Pond. The consultant was charged with developing and implementing a monitoring plan for both wet and dry conditions and characterizing current water quality conditions. The consultant will also estimate pollutant loads and the pond's capacity to assimilate them, allocate allowable loads between identifiable sources, estimate needed pollutant reductions, identify control pollution reduction measures, and develop a draft report for public review. Water quality monitoring was completed in the fall of 2001 and a TMDL is currently under development.

l. Ninigret and Greenhill Ponds

Greenhill Pond and the eastern portion of Ninigret Pond are permanently closed to shellfishing and, as a result, are identified on the state's 303(d) list as impaired for pathogens. Two of Greenhill Pond's largest tributaries, Factory Brook and Teal Brook, are also considered impaired due to pathogens.

From 1999 through 2001, RIDEM conducted field reconnaissance, assessed land use, and monitored water quality in the impaired areas of the pond and their watersheds. Staff are now developing TMDLs for the four waterbodies. It is expected that the TMDLs will be finalized and submitted to EPA in 2002.

m. Yawgoo and Barber Ponds

Yawgoo and Barber Ponds are listed on the 303(d) list for hypoxia, or low dissolved oxygen in the water column. RIDEM is assessing landuse and potential pollution sources in the watershed and using data collected by the URI Watershed Watch program to develop TMDLs for the two ponds. The TMDLs will address phosphorus which is thought to be the limiting nutrient. It is anticipated that these TMDLs will be completed in 2002.

n. Stafford Pond

Stafford Pond is a 480 acre waterbody located in Tiverton, RI. The pond serves as a drinking water supply for residents of Tiverton and Portsmouth. The pond was experiencing frequent algal blooms, leading to taste and odor problems and prompting the Stone Bridge Fire District to upgrade its water treatment practices. In 1995, DEM awarded $107,000 of a state NPS bond fund grant to Fugro East, Inc. to conduct an in-depth limnological investigation of the pond. The goals of the study were to assess the water quality of the pond and its tributaries, identify pollution sources, and develop cost-effective solutions for controlling pollution. The study began in February 1996 and was completed in 1997. Results indicate that the algal blooms are primarily the result of high phosphorus loadings, principally coming from a local dairy farm. The NPS Program has also provided funds for follow-up BMPs. In 2000, the TMDL, which was based upon the results indicated in the 1997 Final Report, was approved by EPA. Implementation of the recommendations outlined in the TMDL have almost been completed. Monitoring of the response of the pond is being implemented by DEM's Office of Water Resources and Division of Agriculture and by the data collected by the Watershed Watch Program.

9. Citizens' Volunteer Monitoring

Citizens' volunteer monitoring has become an important environmental monitoring force within Rhode Island. Its popularity is reflected in the growing number of citizens' volunteer monitoring groups and in the increased number of volunteers and monitoring stations being added to existing citizens' monitoring groups.

RIDEM is represented on the Rhode Island Volunteer Monitoring Steering Board which is an advisory board that oversees volunteer (citizen) monitoring activities around the state. The board facilitates communication between individual citizen groups and has strengthened communication between citizen groups and the state and federal agencies which use their data. Since RIDEM no longer has a fulltime Citizen Monitoring Coordinator position, representation on this board has assisted RIDEM in maintaining an outreach approach with these groups.

The OWR utilizes the data collected by the various Citizen Monitoring groups in the water quality assessments conducted for the 305(b) report. Furthermore, the monitoring data is used as a screening tool to alert the OWR to problem areas where the Department needs to conduct sampling and take action.

10. Quality Assurance

Environmental Protection Agency (EPA) policy requires participation by all EPA regional offices, program offices, EPA laboratories, and states in a centrally managed Quality Assurance (QA) Program. As part of the QA Program, each state is required to develop a QA Program Plan and QA Project Plan(s) for assuring the reliability of monitoring and measurement data. The OWR has developed a QA/QC Plan for the Office. In addition, QA Plans are developed for various projects conducted by and for the OWR. Recently, as part of the Performance Partnership Agreement requirement, the OWR has participated in Departmental meetings to assist in the development of a Departmental QA/QC Plan.